Chemical Nomenclature

What it's all about

- *Chemical nomenclature is the system that is used to identify and name compounds.*
- *Compounds can have*
  - two types of names:
  - *systematic names (names that identify the chemical composition of a chemical compound)*
  - *common names (traditional names based on historical discovery or reactivity behavior).*
- *For example, N_2O* has both a systematic name (dinitrogen monoxide) and a common name (laughing gas).

Terms

- **metalloid** -an element which has the capacity to act as either a metal or a nonmetal, depending on the chemical circumstances

- **nonmetal** -an element that tends to gain electrons, becoming negatively charged; see anion

- **metal** -an element that tends to lose electrons, becoming positively charged; see cation

Terms

anion	another name for a negative ion
cation	another name for a positive ion
metal	elements that tend to gain electrons in reactions (form cations)
nonmetals	elements that tend to lose electrons in reactions (form anions)
monoatomic	one atom
diatomic	two atoms
polyatomic ion	a many atom ion (poly means many) which acts chemically as one unit.

Terms

binary compound	contains two elements
ternary compound	contains three or more elements
ionic compound	made of a positive and a negative ion
molecular compound	atoms share electrons in bond
covalent compounds	same as molecular compound
chemical formula	shows number and kind of atoms in a molecule
structural formula	shows how atoms are connected
hydrates	some compounds have water molecules attached $CuSO_4 \bullet 5H_2O$

I. Binary Compounds of Metals with Fixed Charges

A. Given Formula, Write the Name

1. That **BOTH** the metal **AND** the nonmetal involved in this formula have **ONLY ONE** charge each.

2. The order for names in a binary compound is **first the metal**, **then the nonmetal**

3. Name the metal with a fixed oxidation state directly from the periodic table.

4. The name of the nonmetal will be made from **the root of the element's name plus the suffix "-ide."**

Here are examples of common roots:

F	fluor-
Cl	chlor-
Br	brom-
I	iod-
O	ox-
S	sulf-
N	nitr-
P	phosph-
As	arsen-
Se	selen-
C	carb-

Examples:

- KN_3

- $MgBr_2$

I. Binary Compounds of Metals with Fixed Charges

B. Given Name, Write the Formula

1. All elements involved have **ONLY ONE** charge. **BOTH** the metal **AND** the nonmetal in the formula.

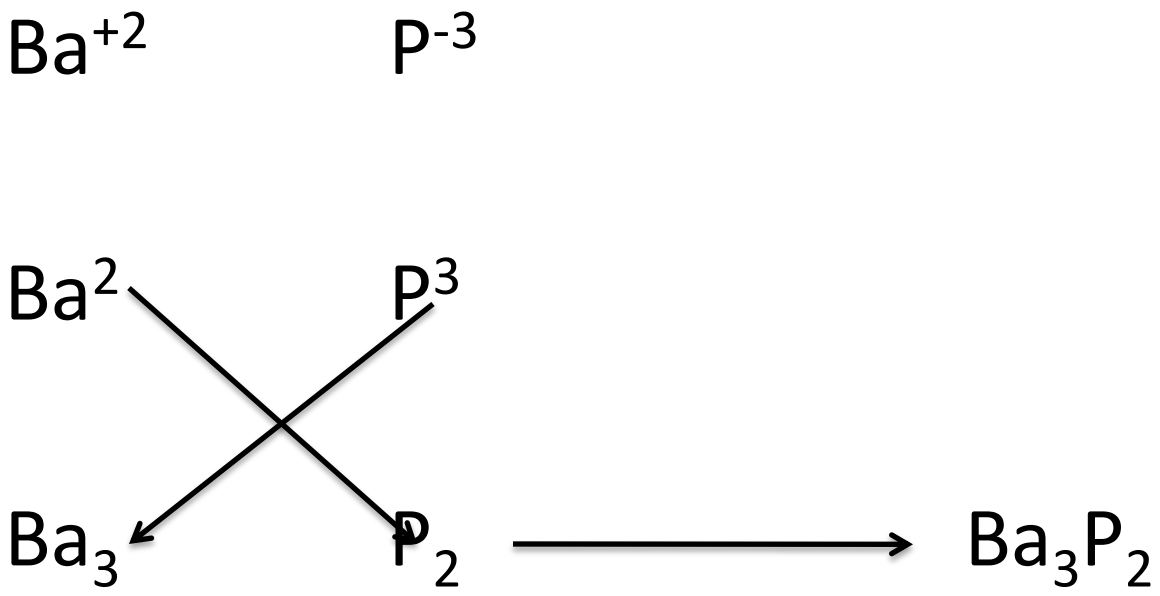
2. Always **metal first**, then **nonmetal second**.

3. The sum of the positive charge and the sum of the negative charges MUST add up to zero.

4. You **MAY NOT** adjust the charges of the cations or anions to get a total charge of zero.

5. You **MAY** adjust the subscripts to get a total charge of zero.

How is that done?



Drop the + & - signs and crisscross the numbers. DONE!!!

Examples:

- aluminum fluoride

- calcium sulfide

II. Binary Compounds of Cations with Variable Charges / Stock System

A. Given Name, Write the Formula

1. Write the formula of a binary compound from the word name when a cation of variable charge is involved.

2. The cations (metals) involved have AT LEAST TWO charges. The anions(nonmetals) involved have only one charge.

Examples:

- lead(IV) sulfide

- iron(III) chloride

II. Binary Compounds of Cations with Variable Charges / Stock system

B. Given Formula, Write the Name

1. Shows you how to name binary compounds from the formula when a cation of variable charge is involved.
2. The **metals** involved have **AT LEAST TWO charges**. The nonmetals involved have only one charge.

Assigning Oxidation Numbers

- The algebraic sum of the oxidation numbers of ALL of the atoms in a compound MUST equal zero.
- An uncombined element (free element) has an oxidation number of zero (0).
- A monatomic ion has an oxidation number equal to its charge.
- Fluorine's oxidation number is –1 in all compounds.

Assigning Oxidation Numbers

- Oxygen has an oxidation number of –2 in all compounds.
- Hydrogen has an oxidation number of +1 except when combined with metals.
- All Group 1 elements will have a +1 oxidation number.
- All Group 2 elements have a +2 oxidation number.
- Aluminum will always be +3.
- Second element in a binary compound is assigned the oxidation number it would have if it were an ion.
- The algebraic sum of the oxidation numbers of ALL atoms in a polyatomic ion is equal to the charge of the ion.
- **WHEN IN DOUBT; ASK THE CHEMISTRY TEACHER**

How to find the correct metal ion?

Pb	Br_4
1(X)	4(-1)
+4	-4

How to find the correct metal ion?

Fe_3	$(PO_4)_2$
3(X)	2(-3)
+6	-6

Examples:

- $FeCl_3$

- SnS_2

III. Binary Compounds of Cations with Variable Charges / Common Name System

- **A. Given Name, Write the Formula**
- IUPAC says the system of indicating valence by means of the suffixes -ous and -ic added to the root of the name of the metal may be retained for elements exhibiting not more than two charges
- **Here is a small list of common names of elements YOU must know.**

Element	Root
iron	"ferr-"
lead	"plumb-"
copper	"cupr-"
tin	"stann-"

Examples

- cupric fluoride

- cuprous oxide

III. Binary Compounds of Cations with Variable Charges / Common Name System

B. Given Formula, Write the Name

1. Find the total charge brought to the formula by the nonmetal.
2. Find the total charge brought to the formula by the metal.

   Divide the total positive charge by the number of ions of metal. This will be the metal's subscript
3. Check to be sure that the calculated ion charge is correct for that specific ion.
4. Name the root of the metal and add **–ic** or **–ous**
   a) –ous is the lower oxidation number
   b) –ic is the higher oxidation number

Examples

- ferric bromide

- ferrous oxide

IV. Binary Compounds of Two Nonmetals
The Greek System

A. Given Formula, Write the Name

1. the Greek method involves use of Greek prefixes when naming binary compounds of **two nonmetals**.
2. **NO metals are involved**.

   You do not even need to know the charges, since the formula comes right from the element names and their prefixes.

3. Here are the ten you need to know:

Number	Prefix	Number	Prefix
one	mono-	six	hexa-
two	di-	seven	hepta-
three	tri-	eight	octa-
four	tetra-	nine	nona-
five	penta-	ten	deca-

Examples

- SiO_2

- CCl_4

IV. Binary Compounds of Two Nonmetals
The Greek System

B. Given Name, Write the Formula

1. Determine the number of atoms of the 1st element by the prefix.

2. Determine the name of the 1st element.

3. Write the symbol of the 1st element and the use the prefix number as the subscript.

4. Determine the number of atoms of the 2nd element by the prefix.

5. Determine the symbol of the second element

6. Write the symbol of the second element and use the prefix number as the subscript.

Example:

- carbon tetrafluoride

- Diboron tetrahydride

V. Compounds Involving a Polyatomic Ion

A. Given Formula, Write the Name

1. These compounds to follow ARE NOT binary compounds. They contain three or more elements.
2. Consequently, a warning: it is important that you learn to recognize the presence of a polyatomic ion in a formula. (see next slide)
3. The metals used will be a mix of fixed charges AND variable charges.

V. Compounds Involving a Polyatomic Ion

Use of Parenthesis

When more than one polyatomic ion is required, parenthesis are used to enclose the ion with the subscript going outside the parenthesis.

For example, the very first formula used is $Fe(NO_3)_2$. This means that two NO_3^- ions are involved in the compound.

Without the parenthesis, the formula would be $FeNO_{32}$, a far cry from the correct formula.

Common Polyatomic ions YOU need to know

Symbol	Name
NO_3^{-1}	Nitrate
NO_2^{-1}	Nitrite
OH^{-1}	hydroxide
CO_3^{-2}	carbonate
PO_4^{-3}	Phosphate
HCO_3^{-1}	Bicarbonate
SO_4^{-2}	Sulfate
SO_3^{-2}	Sulfite
MnO_4^{-1}	Permanganate
CrO_4^{-2}	Chromate
ClO^{-1}	Hypochlorite

Examples

- write the name for $Fe(NO_3)_2$

- Write the name for $(NH_4)_2SO_4$

V. Compounds Involving a Polyatomic Ion

B. Given Name, Write the Formula

1. Write the symbol and charge of the metal ion.

2. Write the symbol and charge of the polyatomic ion.

3. Drop the charges and crisscross the numbers.

4. *When more than one polyatomic ion is needed in a formula, parentheses are used to denote the ions.*
5. *Subscripts are placed outside of the parentheses.*

Examples

- **IMPORTANT**: You have to:
  - recognize when a polyatomic is present and
  - know its name and what to do with it.
- copper (II) nitrite

- iron (II) phosphate

VI. Nomenclature of Inorganic Acids

- **Recognizing an Acid**
- At this very beginning level, you will recognize an acid by the fact that its formula starts with H, as in these examples:
- **H**Cl
  HNO_3
  $\mathbf{H_2}SO_4$
  HClO_3
  $\mathbf{H_3}BO_3$
- There is one exception to this: the formula CH_3COOH should be recognized as acetic acid. The particular way it is written is common in organic chemistry. An alternate way to write acetic acid is $HC_2H_3O_2$. This is done in the inorganic style that you are currently studying.

VI. Nomenclature of Inorganic Acids

- In order to explain acid naming, the sequence of HCl, HClO, $HClO_2$, $HClO_3$, and $HClO_4$ will be discussed in order.

- HCl is a binary acid. All binary acids are named the same way:
- the prefix "hydro" is used.
- the root of the nonmetal is used.
- the suffix "ic" is used.
- the word "acid" is used as the second word in the name.
- The name for HCl is hydrochloric acid. Other binary acids you are responsible for are HF, HBr, HI, and H_2S.

VI. Nomenclature of Inorganic Acids

- 1) HClO is an acid involving a polyatomic ion. You MUST recognize the polyatomic ion in the formula. There is no other way to figure out the name. If you don't recognize the polyatomic, then you're sunk without a trace.
- The polyatomic ion is ClO^- and its name is hypochlorite. Any time you see the "ite" suffix, you change it to "ous" and add the word acid.
- The name of HClO is hypochlorous acid.
- 2) $HClO_2$ has the ClO_2^- polyatomic ion in it. The name of this ion is chlorite.
- Since the "ite" suffix is used, it gets changed to "ous."
- The name of $HClO_2$ is chlorous acid.

VI. Nomenclature of Inorganic Acids

Common Acid and Anion Names

Acid	Name	Anion	Name		Acid	Name	Anion	Name
H_2SO_4	sulfuric	SO_4^{2-}	sulfate		HCl	hydrochloric	Cl^-	chloride
HNO_3	nitric	NO_3^-	nitrate		HBr	hydrobromic	Br^-	bromide
H_3PO_4	phosphoric	PO_4^{3-}	phosphate		$HClO_3$	chloric	ClO_3^-	chlorate
$HC_2H_3O_2$	acetic	$C_2H_3O_2^-$	acetate		$HClO_2$	chlorous	ClO_2^-	chlorite
H_2SO_3	sulfurous	SO_3^{2-}	sulfite		$HBrO_3$	bromic	BrO_3^-	bromate
HNO_2	nitrous	NO_2^-	nitrite		HBrO	hypobromous	BrO^-	hypobromite